when assayed by means of the sulphate of potash, did not present the slightest portion of dissolved lead; the ninth was charged with the latter metal. Hydro-sulphuretted water discovered the tin which was dissolved in the first eight liquids.

These experiments were repeated three times with vinegar of different strength, and the same results were obtained. The tin, which is always more soluble and more easy to be oxidated than the lead, easily suffers itself to be attacked by the vinegar, but the lead not at all. The vessels, after the vinegar has been kept in them, appear, indeed, of a leaden colour, and to abound more with lead than the piece does in its substance; but the slightest friction detaches the light stratum which is formed at the surface, and restores the surface to its original state.

It is well known that the poorest pewter, such as that of twenty per cent., is never employed in the fabrication of the utensils which serve for preparing and preserving our aliments and drinks. But, even though a dishonest pewterer should employ it, his alloy can never be injurious to health, since vinegar may be kept in vessels alloyed with thirty-three or fifty per cent. of lead, without its being possible to detect a sensible quantity of this metal in it. And as to the arsenic which Malouin, Geoffroy, and Margraaf had detected in some tin, the supposed danger thence arising was soon dissipated by the work which Bayen wrote upon this subject by order of the police of Paris, and in which he observes that a pewter plate which he had employed for two years at all his meals had lost only four grains of its weight, and that the arsenic which could be contained in these four grains, detached by scouring the plate, rather than introduced into the stomach, did not amount probably to 1-6000th of a grain per day.

Phalangosis, in *surgery*, is a tumor and relaxation of the eye-lids, often so great as to deform the eye, and considerably to impede vision. Sometimes the eye-lid when in this state subsides or sinks down, occasioned perhaps either by a palsy of the muscle which sustains and elevates the eye-lid, or else from a relaxation of the cutis above. Sometimes an aqueous tumor is formed on the eye-lids, so as almost entirely to exclude vision; but this last case should be distinguished from the other, and may be easily remedied by the use of internal and topical medicines. But, in the paralytic or relaxed case, the use of cordial and nervous medicines must be employed internally; and balsam of Peru outwardly.

Phalanx, in the *military science;* a square battalion of soldiers, with their shields joined and pikes crossing each other; so that it was next to impossible to break it.

The Macedonian phalanx is supposed by some to have had the advantage, in valour and strength, over the Roman legion. Its number was 8000 men. But the word *phalanx* is used for a party of twenty-eight, and several other numbers; and even sometimes for the whole body of foot.

Phalanx, *in anatomy;* the small bones which form the fingers.

Pharmaca, among the ancients, meant medicated or enchanted compositions of herbs, minerals, &c., some of which, when taken inwardly, were supposed to cause blindness, madness, love, &c.; others were supposed to be capable of communicating infection by the mere touch; such was the garment sent by Medea to Creusa; whilst others operated upon persons at a distance.

Pharmacopœia; a treatise describing the preparations of medicines, with their uses, manner of application, &c. We have various pharmacopœias, as those of Bauderon, Quercetan, Zwelfer, Charas, Bates, Salmon, Lemery, Lewis, &c. The latest and most approved are the Edinburgh and London collections: the latter has received valuable corrections from the pen of Mr. R. Phillips.

Pharmacy is the art of preparing and compounding medicines, and may be traced to the earliest eras of medical records. When medicines were first given, some preparation was, of course, necessary; and we find in Hippocrates not only ointments, but infusions of different vegetable substances in oils, called from the basis, *myrtinum, rosatum,* &c. In fumigations he employed troches, which required preparation. It is probable that this union of pharmacy with the practice of medicine continued for many ages; for we do not find it as a separate profession at Rome till the time of Theophrastus. To the Arabians we are, however, indebted for the more complicated processes of pharmacy. They multiplied the number of distilled waters, prepared tinctures and syrups, and accumulated the ingredients of their formulæ. The first great division of pharmacy was, however, effected by the chemical sect, early in the sixteenth century. This introduced the distinction of preparations into *Galenical* and *chemical,* the former containing the decompositions and preparations in which the heat was inconsiderable, indeed not greatly superior to that of boiling water, the latter those produced by the most intense heat of a furnace.

We have seen that the great object of pharmacy is to provide those substances which may be employed for the prevention or cure of disease. To attain this object completely, an acquaintance with the chemical and physical properties of these bodies is necessary. This may be termed the *science* of *pharmacy;* and, as few substances are found in nature in a state fit for their exhibition in medicine, the various preparations which they previously undergo constitute the *art* of pharmacy. The chemical characters of the various bodies employed in pharmaceutical preparations will be found illustrated under their separate heads in this work, and we must in the present case confine ourselves to those manipulations and apparatus alone which, though of importance to the pharmaceutic chemist, would not properly have a place in the ordinary alphabetical arrangement.

Each of the kingdoms of nature furnishes substances which are employed in medicine, either in their natural state or after they have been prepared by the art of pharmacy. In collecting these, attention must be paid to select such as are most sound and perfect, to separate from them whatever is injured or decayed, and to free them from all foreign matters. Those precautions must be taken which are best fitted for preserving them. They must, in general, be defended from the effects of moisture, too great heat or cold, and confined air. When their activity depends on volatile principles, they must be preserved from the contact of the air as much as possible.

As the vegetable kingdom presents us with the greatest number of simples, and the substances be-

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longing to it are the least constant in their properties, and most subject to decay, it becomes necessary to give a few general rules for their collection and preservation.

Vegetable matters should be collected in the countries where they are indigenous; and those which grow wild, in dry soils and high situations, fully exposed to the air and sun, are in general to be preferred to those which are cultivated, or which grow in moist, low, shady, or confined places.

Roots which are annual should be collected before they shoot out their stalks or flowers; biennial roots in the autumn of the first, or spring of the second year; perennial roots either in spring before the sap has begun to mount, or in harvest after it has returned.

Those which are worm-eaten, except some resinous roots, or which are decayed, are to be rejected. The others are immediately to be cleaned with a brush and cold water, letting them lie in it as short a time as possible; and the fibres and little roots, when not essential, are to be cut away.

Roots which consist principally of fibres may be immediately dried. If they be juicy, and not aromatic, this may be done by heat, not exceeding 100° of Fahrenheit; but if aromatic, by simply exposing them, and frequently turning them in a current of dry air; if very thick and strong, they are to be split or cut into slices, and strung upon threads; if covered with a tough bark, they may be peeled fresh, and then dried. Farinaceous roots are to be dipt in boiling water before they are dried. Such as lose their virtues by drying, or are directed to be preserved in a fresh state, are to kept buried in dry sand. Ginger is usually peeled and preserved in syrup.

No very general rule can be given for the collection of herbs and leaves; some of them acquiring activity from their age; and others, as the mucilaginous leaves, from the same cause, losing the property for which they are officinal. Aromatics are to be collected after the flower-buds are formed, annuals, not aromatic, when they are about to flower, or when in flower, biennials before they shoot, and perennials before they flower, especially if their fibres become woody.

They are to be gathered in dry weather, after the dew is off them, or in the evening, before it falls, and are to be freed from decayed or foreign leaves. They are usually tied in bundles, and hung up in a shady, warm, and airy place; or spread upon the floor, and frequently turned. If very juicy, they are laid upon a sieve, and dried by a gentle degree of artificial warmth. Sprouts are collected before the buds open; and stalks are gathered in autumn.

Barks and woods are collected in spring or in autumn, when the most active parts of the vegetable are concentrated in them. Spring is preferred for resinous barks, and autumn for the others which are not resinous, but rather gummy. Barks should be taken from young trees, and freed from decayed parts, and all impurities. The same rules are to be followed in collecting woods, which, however, must not be taken from very young trees. Among the resinous woods, the heaviest, which sink in water, are selected. The alburnum is to be rejected.

Flowers are to be collected in clear dry weather, before noon, but after the dew is off, either when they are just about to open or immediately after they have opened. Of some the petals only are preserved, and the colourless portions are even cut away; of others, whose calyx is odorous, the whole flower is kept. Flowers which are too small to be pulled singly are dried with part of the stalk; these are called heads or tops. Flowers are to be dried nearly in the same manner as leaves, but more quickly, and with more attention. As they must not be exposed to the sun, it is best done by a slight degree of artificial warmth; and in some cases they should be put up in paper bags. When they lose their colour and smell they are unfit for use.

Seeds and fruits, unless when otherwise directed, are to be gathered when ripe, but before they fall spontaneously. The emulsive and farinaceous seeds are to be dried in an airy, cool place; the mucilaginous seeds by the heat of a stove. Some pulpy fruits are freed from their core and seeds, strung upon thread, and dried artificially, by exposing them repeatedly to the heat of a stove. They are in general best preserved in their natural coverings, although some, as the colocynth, are peeled, and others, as the tamarind, immersed in syrup. Many seeds and fruits are apt to spoil, or become rancid; and, as they are then no longer fit for medical use, no very large quantity of them should be collected at a time.

The proper drying of vegetable substances is of the greatest importance. It is often directed to be done in the shade, and slowly, that the volatile and active particles may not be dissipated by too great heat: but this is an error; for they always lose infinitely more by slow than by quick drying. When, on account of the colour, they cannot be exposed to the sun, and the warmth of the atmosphere is insufficient, they should be dried by an artificial warmth, less than 100° Fahrenheit, and exposed to a free current of air. When perfectly dry and friable, they have little smell; but, after being kept some time, they attract moisture from the air, and regain their proper odour. The boxes and drawers in which vegetable substances are kept should not impart to them any smell or taste; and, more certainly to avoid this, they should be lined with paper. Such as are volatile, of a delicate texture, or subject to suffer from insects, must be kept in well-covered glasses. Fruits and oily seeds, which are apt to become rancid, must be kept in a cool and dry, but by no means in a warm or moist place.

Oily seeds, odorous plants, and those containing volatile principles, should be collected fresh every year; others, whose properties are more permanent, and not subject to decay, will keep for several years.

Vegetables collected in a moist and rainy season, are in general watery, and apt to spoil. In a dry season, on the contrary, they contain more oily and resinous particles, are more active, and keep much better.

We may now proceed to examine the mechanical operations of pharmacy, commencing with the best mode of determining the weight and bulk of those bodies employed by the pharmaceutical chemist. For this purpose there should be sets of beams and scales of different sizes; and it would be advisable to have a double set, one for ordinary use, and another for occasions when greater accuracy is necessary. A good beam should remain in equilibrium both by itself and when the scales are suspended, one to either end indifferently; and it should turn sensibly with a very small proportion of the weight with which it is loaded. Balances should be defended as

much as possible from acid and other corrosive vapours, and should not be overloaded, or left suspended longer than is necessary, as their delicacy is thereby very much impaired. It may not be unnecessary to mention that the scales and weights, as well as measures, funnels, mortars, &c., should be kept extremely clean. Some apothecaries have their scales made of glass, ivory, or tortoise shell.

For measuring fluids, the graduated glass measures are always to be preferred: they should be of different sizes, according to the quantities they are intended to measure. Elastic fluids are also measured in glass tubes and jars, graduated by inches and their decimals.

The practice of administering active fluids by drops has been long known to be inaccurate. Not only do the drops of different fluids from the same vessel, and of the same fluids from different vessels, differ much in size; but it appears that the drops of the same fluid differ, even to the extent of a third, from different parts of the lip of the same vessel. The custom of dropping active fluids should therefore be abolished entirely; and, as weighing is too troublesome and difficult for general use, we must have recourse to small measures, accurately graduated, in the manner of Lane's *drop* measure.

By mechanical division, substances are reduced to a form better adapted for medical purposes; and, by the increase of their surface, their action is promoted, both as medical and chemical agents. It is performed by cutting, bruising, grinding, grating, rasping, filing, pulverization, trituration, and granulation, by means of machinery or of proper instruments.

Pulverization is the first of these operations that is commonly employed in the apothecary's shop. It is performed by means of pestles and mortars. The bottom of the mortars should be concave; and their sides should neither be so inclined as not to allow the substance operated on to fall to the bottom between each stroke of the pestle, nor so perpendicular as to collect it too much together, and to retard the operation. The materials of which the pestles and mortars are formed should resist both the mechanical and chemical action of the substances for which they are used. Wood, iron, marble, siliceous stones, porcelain, and glass, are all employed; but copper, and metals containing copper, are to be avoided. It may be proper to add that they should be provided with covers to prevent the finest and lightest parts from escaping, and to defend the operator from the effects of disagreeable or noxious substances. But these ends are more completely attained by tying a piece of pliable leather round the pestle and round the mouth of the mortar. It must be closely applied, and at the same time so large as to permit the free motion of the pestle.

In some instances it will be even necessary for the operator to cover his mouth and nostrils with a wet cloth and to stand with his back to a current of air, that the acrid particles which arise may be carried from him.

The addition of a little water or spirit of wine or of a few almonds to very light and dry substances will prevent their flying off. But almonds are apt to induce rancidity, and powders are always injured by the drying which is necessary when they have been moistened. Water must never be added to substances which absorb it, or are rendered cohesive by it. Too great a quantity of any substance must never be put into the mortar at the same time, as it very much retards the operation.

All vegetable substances must be previously dried. Resins and gummy resins which become soft in summer must be powdered in very cold weather, and must be beaten gently or they will be converted into a paste, instead of being powdered. Woods, roots, barks, horn, bone, ivory, &c., should be previously cut, split, chipped, or rasped. Fibrous woods and roots should be finely shaved after their bark is removed or otherwise their powders will be full of hair-like filaments, which can scarcely be separated. Some substances will even require to be moistened with mucilage of tragacanth, or of starch, and then dried before they can be powdered. Camphor may be conveniently powdered by the addition of a little spirit of wine or almond oil. The emulsive seeds cannot be reduced to powder unless some dry powder be added to them. To aromatic oily substances, sugar is the best addition. All impurities and inert parts having been previously separated, the operation must be continued and repeated upon vegetable substances till no residuum is left. The powders obtained at different times must then be intimately mixed together, so as to bring the whole to a state of perfect uniformity.

Very hard stony substances must be repeatedly heated to a red heat, and then suddenly quenched in cold water until they become sufficiently friable. Some metals may be powdered hot in a heated iron mortar or may be rendered brittle by alloying them with a little mercury.

Trituration is intended for the still more minute division of bodies. It is performed in flat mortars of glass, agate, or other hard materials, by giving a rotatory motion to the pestle; or on a levigating stone, which is generally of porphyry, by means of a muller of the same substance. On large quantities it is performed by rollers of hard stone, turning horizontally upon each other, or by one vertical roller turning on a flat stone.

Levigation differs from trituration only in the addition of water or spirit of wine to the powder operated upon, so as to form the whole mass into a kind of paste, which is rubbed until it is of sufficient smoothness or fineness. Earths and some metallic substances are levigated. The substances subjected to this operation are generally previously powdered or ground.

Granulation is employed for the mechanical division of some metals. It is performed either by stirring the melted metal with an iron rod until it cools, or by pouring it into water and stirring it continually as before, or by pouring it into a covered box, previously well rubbed with chalk, and shaking it until the metal cools, when the rolling motion will be converted into a rattling one. The adhering chalk is then to be washed away.

From dry substances, which are reduced to the due degree of minuteness, the coarser particles are to be separated by sieves of iron-wire, hair-cloth, or gauze, or by being dusted through bags of linen. For very light and valuable powders, or acrid substances, compound sieves, having a close lid and receiver, must be used. The particles which are not of sufficient fineness to pass through the interstices of the sieve may be again powdered.

Elutriation is performed on mineral substances, on which water has no action, for separating them from

foreign particles and impurities, of a different specific gravity, in which case they are said to be washed; or for separating the impalpable powders obtained by trituration and levigation from the coarser particles. This process depends upon the property that very fine or light powders have of remaining for some time suspended in water; and is performed by diffusing the powder or paste formed by levigation through plenty of water, letting it stand a sufficient time, until the coarser particles settle at the bottom, and then pouring off the liquid in which the finer or lighter particles are suspended. Fresh water may be poured on the residuum, and the operation repeated; or the coarser particles which fall to the bottom may be previously levigated a second time. The fine powder which is washed over with the water, is separated from it, by allowing it to subside completely, and by decanting off the water very carefully.

Decantation is very frequently made use of for separating the clear from the turbid part of a fluid, and for separating fluids from solids, which are specifically heavier, especially when the quantity is very large, or the solid so subtile as to pass through the pores of most substances employed for filtration, or the liquid so acrid as to corrode them.

For the purposes of separating fluids from solids, straining and filtration are often resorted to. These differ only in degree, and are employed when the powder either does not subside at all, or too slowly and imperfectly for decantation.

The instruments for this purpose are of various materials, and must in no instance be acted upon by the substances for which they are employed. Fats, resins, wax, and oils, are strained through hemp or flax, spread evenly over a piece of wire cloth or net stretched in a frame. For saccharine and mucilaginous liquors, fine flannel may be used; for some saline solutions, linen. Where these are not fine enough, unsized paper is employed, but it is extremely apt to burst by hot watery liquors. Very acrid liquors, such as acids, are filtered by means of a glass funnel, filled with powdered quartz, a few of the larger pieces being put in the neck, smaller pieces over these, and the fine powder placed over all. The porosity of this last filter retains much of the liquor; but it may be obtained by gently pouring on it an equal quantity of distilled water; the liquor will then pass through, and the water will be retained in its place.

Water may be filtrated in large quantities through basins of porous stone, or artificial basins of nearly equal parts of fine clay and coarse sand. In large quantities it may be easily purified *per ascensum*, the purified liquor and impurities thus taking opposite directions. The simplest apparatus of this kind is a barrel, divided perpendicularly by a board perforated with a row of holes along the lower edge. Into each side, as much well-washed sand is put as will cover these holes an inch or two, over which must be placed a layer of pebbles to keep it steady. The apparatus is now fit for use. Water poured into the one half will sink through the sand in that side, pass through the holes in the division to the other, and rise through the sand in the other half, from which it may be drawn by a stop-cock.

The size of the filters depends on the quantity of matter to be strained. When large, the flannel or linen is formed into a conical bag, and suspended from a hoop or frame; the paper is either spread on the inside of these bags, or folded into a conical form, and suspended by a funnel. It is of advantage to introduce glass rods or quills between the paper and funnel, to prevent them from adhering too closely.

What passes first is seldom fine enough, and must be poured back again, until by the swelling of the fibres of the filter, or filling up of its pores, the fluid acquires the requisite degree of limpidity. The filter is sometimes covered with charcoal powder, which is a useful addition to muddy and deep-coloured liquors. The filtration of some viscid substances is much assisted by heat.

Expression is a species of filtration, assisted by mechanical force. It is principally employed to obtain the juices of fresh vegetables, and the unctuous vegetable oils. It is performed by means of a screw press, with plates of wood, iron, or tin. The subject of the operation is previously beaten, ground, or bruised. It is then enclosed in a bag, which must not be too much filled, and introduced between the plates of the press. The bags should be of hair-cloth, or canvass enclosed in hair-cloth. Hempen and woollen bags are apt to give vegetable juices a disagreeable taste. The pressure should be gentle at first, and increased gradually.

Vegetables intended for this operation should be perfectly fresh, and freed from all impurities. In general they should be expressed as soon as they are bruised, for it disposes them to ferment; but subacid fruits give a larger quantity of juice, and of a finer quality, when they are allowed to stand some days in a wooden or earthen vessel after they are bruised. To some vegetables which are not juicy enough the addition of a little water is necessary. Lemons and oranges must be peeled, as their skins contain a great deal of essential oil, which would mix with the juice. The oil itself may be obtained separately, by expression with the fingers on a piece of glass.

For unctuous seeds iron plates are used; and it is customary not only to heat the plates, but to warm the bruised seeds in a kettle over the fire, after they have been sprinkled with water, as by these means the product is increased, and the oil obtained is more limpid. But, as the oils obtained in this way are more disposed to rancidity, this process should either be laid aside altogether or changed to a simple exposure of the bruised seeds to the steam of hot water.

Despumation is generally practised on thick and clammy liquors, which contain much slimy and other impurities, not easily separable by filtration. The scum is made to arise either by simply heating the liquor, or by *clarifying* it, which last is done by mixing with the liquor, when cold, white of egg well beaten with a little water, which on being heated coagulates, and rises to the surface, carrying with it all the impurities. The liquor may now be filtered with ease, or may be skimmed with a perforated ladle. Spirituous liquors are clarified, without the assistance of heat, by means of isinglass dissolved in water, or of any albuminous fluid, as milk, which coagulates with the action of alcohol. Some expressed juices, as those of all the antiscorbutic plants, are instantly clarified by the addition of any vegetable acid, as the juice of bitter oranges.

Fluids can be separated from each other only when they have no tendency to combine, and when

they differ in specific gravity. The separation may be effected by skimming off the lighter fluid with a silver or glass spoon; or by drawing it off by a syringe or syphon; or by means of a glass separatory, which is an instrument having a projecting tube, terminating in a very slender point, through which the heavier fluid alone is permitted to run; or by means of the capillary attraction of a spongy woollen thread; for no fluid will enter a substance whose pores are filled by another, for which it has no attraction; and, lastly, upon the same principle, by means of a filter of unsized paper, previously soaked in one of the fluids, which in this way readily passes through it, while the other remains behind.

The apparatus employed in pharmaceutic chemistry will next engage our attention. They may be placed under three heads :—1. The vessels in which the processes are performed; 2. Fuel, or the means of producing heat; and 3. The means of applying and regulating the heat, by lamps and furnaces.

The vessels, according to the purposes for which they are intended, vary both in form and in materials.

No substance possesses properties which render it proper to be employed as a material in every instance. We are therefore obliged to select those substances which possess the properties more especially required in the particular operations for which they are intended. The properties most generally required, are; 1. The power of resisting chemical agents; 2. Transparency; 3. Compactness; 4. Strength; 5. Fixity and infusibility; and 6. The power of bearing sudden variations of temperature without breaking.

The metals in general possess the four last properties in considerable perfection, but they are all opaque. Iron and copper are apt to be corroded by chemical agents, and the use of the latter is often attended with dangerous consequences. These objections are in some measure, but not entirely, removed by tinning them. Tin and lead are too fusible. Platinum, gold, and silver, resist most of the chemical agents, but their expense is an insurmountable objection to their general use.

Good earthenware resists a high degree of heat, but is deficient in all the other properties. The basis of all kinds of earthenware is clay, which possesses the valuable quality of being very plastic when wrought with water, and of becoming extremely hard when burnt with an intense heat. But it contracts so much by heat, that it is extremely apt to crack and split, on being exposed to sudden changes of temperature; it is therefore necessary to add some substance which may counteract this property. Siliceous sand, clay reduced to powder and then burnt with a very intense heat, and plumbago, are occasionally used. These additions, however, are attended with other inconveniences; plumbago, especially, is liable to combustion, and sand diminishes the compactness, so that it becomes necessary to glaze most kinds of earthenware; but, when glazed, they are acted upon by chemical agents.

Glass possesses the first three qualities in an eminent degree, and may be heated red hot without melting. Its greatest inconvenience is its disposition to crack, or break in pieces, when suddenly heated or cooled. As this is occasioned by its unequal expansion or contraction, glass vessels should be made very thin, and of a round form. They should also be well annealed, that is cooled very slowly, when blown, by placing them immediately in a heated oven, while they are yet in a soft state. When ill annealed, or cooled suddenly, glass is apt to fly in pieces on the slightest change of temperature, or touch of a sharp point. We sometimes take advantage of this imperfection; for by means of a red-hot wire, or tobacco pipe, glass vessels may be cut into any shape. When there is not a crack already in the glass, the point of the wire is applied near the edge, a crack is formed, which is afterwards easily led in any direction.

Having thus pointed out the various materials of which the vessels employed in pharmaceutical processes should be formed, we may next examine the *lutes* for connecting and coating them. They consist of compositions of various substances, and are intended to close the joinings of vessels; to coat glass vessels; to line furnaces. Lutes of the first description are commonly employed to confine elastic vapours. They should therefore possess the following properties :—Viscidity, plasticity, and compactness; the power of resisting acrid vapours; and the power of resisting certain degrees of heat.

The viscidity of lutes depends on the presence either of 1. Unctuous or resinous substances; 2. Mucilaginous substances, or 3. Clay or lime.

Lutes of the first kind are exceedingly valuable; but they are in general so fusible that they cannot be employed when they are exposed even to very low degrees of heat, and they will not adhere to any substance that is at all moist. The following may be taken as examples :—

Eight parts of yellow wax, melted with one of oil of turpentine, with or without the addition of resinous substances, according to the degree of pliability and consistence required. Four parts of wax, melted with two of varnish and one of olive oil. Three parts of powdered clay, worked up into a paste with one of drying oil, or, what is better, amber varnish. The drying oil is prepared by boiling 22.5 parts of litharge in 16 of linseed oil until it be dissolved. Chalk and oil, or glazier's putty, is well fitted for luting tubes permanently into glass vessels, for it becomes so hard that it cannot be easily removed. Equal parts of litharge, quicklime, and powdered clay, worked into a paste with oil varnish, is sometimes applied over the cracks in glass vessels, so as to fit them for many purposes. Melted pitch and brick dust form a good cement.

Mucilaginous substances, such as flour, starch, gum, and glue, mixed with water, are sufficiently adhesive, are dried by moderate degrees of heat, and are easily removed after the operation, by moistening them with water; but a high temperature destroys them, and they do not resist corrosive vapours. The addition of an insoluble powder is often necessary to give them a sufficient degree of consistency. The following are examples of useful lutes :—

Slips of bladder, softened in water, and applied with the inside next the vessels. They are apt, however, from their great contraction in drying, to break weak vessels. One part of gum-Arabic with six or eight of chalk, formed into a paste with water. Flour worked into a paste with powdered clay or chalk. Almond or linseed meal formed into a paste with mucilage or water. Quicklime in fine powder, hastily mixed with white of egg, and instantly applied, sets very quickly, but becomes so hard that it can

scarcely be removed. Slaked lime in fine powder, with glue, does not set so quickly as the former. The cracks of glass vessels may be cemented by coating them and a suitable piece of linen over with white of egg, strewing both over with finely powdered quicklime, and instantly applying the linen closely and evenly.

Earthy lutes resist very high temperatures, but they become so hard that they can scarcely be removed, and often harden so quickly after they are mixed up that they must be applied immediately. Three or four examples may suffice :—

1. Quicklime well incorporated with a sixth part of muriate of soda. 2. Burnt gypsum, made up with water. 3. One ounce of borax dissolved in a pound of boiling water, mixed with a sufficient quantity of powdered clay. 4. One part of clay with four of sand, formed into a paste with water. This is also used for coating glass vessels, in order to render them stronger, and capable of resisting intense heat. It is then made into a very thin mass, and applied in successive layers, taking care that each coat be perfectly dry before another be laid on.

The junctures of vessels which are to be luted to each other should previously be accurately and firmly fitted, by introducing between them, when necessary, short pieces of wood or cork, or, if the disproportion be very great, by means of a cork fitted to the one vessel, having a circular hole bored through it, through which the neck of the other vessel or tube may pass. After being thus fitted, the lute is either applied very thin, by spreading it on slips of linen or paper, and securing it with thread; or, if it is a paste lute, it is formed into small cylinders, which are successively applied to the junctures, taking care that each piece be made to adhere firmly and perfectly close in every part before another is put on. Lastly, the whole is secured by slips of linen or bladder.

In many cases, to permit the escape of elastic vapours, a small hole is made through the lute with a pin, or the lute is perforated by a small quill, fitted with a stopper.

We come now to treat of the various applications of heat and fuel. As caloric is an agent of the most extensive utility in the chemical operations of pharmacy, it is necessary that we should be acquainted with the means of employing it in the most economical and efficient manner.

The rays of the sun are used in the drying of many vegetable substances; and the only attentions necessary, are to expose as large a surface as possible, and to turn them frequently, that every part may be dried alike. They are also sometimes used for promoting spontaneous evaporation.

Combustion is a much more powerful and certain source of heat. Alcohol, oil, tallow, wood, turf, coal, charcoal, and coke, are all occasionally employed. The first three can only be burnt on porous wicks, which draw up a portion of the fluid to be volatilized and inflamed. Fluid inflammables are therefore burnt in lamps of various constructions. But, although commonly used to produce light, they afford a uniform, but not high temperature. This may, however, be increased by increasing the number and size of the wicks. Alcohol produces a steady heat, no soot, and, if strong, leaves no residuum. Oil gives a lower temperature, and on a common wick produces much smoke and soot. These are diminished, and the light and heat increased, by making the surface of the flame bear a large proportion to the centre, which is best done by a cylindrical wick, so contrived that the air has free access both to the outside and inside of the cylinder, as in the Argand's lamp. In this way oil may be made to produce a considerable temperature, of great uniformity, and without the inconvenience of smoke.

Wicks have the inconvenience of being charred by the high temperature to which they are subjected, and becoming so clogged as to prevent the fluid from rising in them. They must then be trimmed; but this is seldomer necessary with alcohol and fine oils than with the coarser oils. Lamps are also improved by adding a chimney to them. It must admit the free access of air to the flame, and then it increases the current, confines the heat, and steadies the flame. The intensity of the temperature of flame may be greatly increased by forcing a small current of hot air through it, as by the blow-pipe.

Wood, turf, coal, charcoal, and coke, which are solid combustibles, are burnt in furnaces. Wood has the advantage of kindling readily, but affords a very unsteady temperature, is inconvenient from its flame, smoke, and soot, and requires much attention. The heavy and dense woods give the greatest heat, burn longest, and leave a dense charcoal.

Dry turf gives a steady heat, and does not require so much attention as wood; but it consumes fast, its smoke is copious and penetrating, and the empyreumatic smell which it imparts to every thing it comes in contact with adheres to them with great obstinacy. The heavy turf of marshes is preferable to the light surface turf.

Coal is the fuel most commonly used in this country. Its heat is considerable, and sufficiently permanent, but it produces much flame and smoke.

Charcoal, especially of the dense woods, is a very convenient and excellent fuel. It burns without flame or smoke, and gives a strong, uniform, and permanent heat, which may be easily regulated, especially when it is not in too large pieces, and is a little damp. But it is costly, and burns quickly.

Coke, or charred coal, possesses similar properties with charcoal: it is less easily kindled, but is capable of producing a higher temperature, and burns more slowly.

When an open grate is used for chemical purposes it should be provided with cranes to support the vessels, that they may not be overturned by the burning away of the fuel.

The furnace must next be examined. In all furnaces the principal objects are to produce a sufficient degree of heat, with little consumption of fuel, and to be able to regulate the degree of heat.

An unnecessary waste of fuel is prevented by forming the sides of the furnace of very imperfect conductors of caloric, and by constructing it so that the subject operated on may be exposed to the full action of the fire.

The degree of heat is regulated by the quantity of air which comes in contact with the burning fuel. The quantity of air is in the compound ratio of the size of the aperture through which it enters, and its velocity. The velocity is increased by mechanical means, as by bellows, or by increasing the height and width of the chimney.

The size and form of furnaces, and the materials of which they are constructed, are various, according to the purposes for which they are intended.

The essential parts of a furnace are,—a body for the fuel to burn in, a grate for it to burn upon, an ash-pit to admit air and receive the ashes, and a chimney for carrying off the smoke and vapours.

The ash-pit should be perfectly close, except the door, which should be furnished with a register-plate to regulate the quantity of air admitted. The bars of the grate should be triangular and placed with an angle pointed downwards and not above half an inch distant. The grate should be fixed on the outside of the body.

The body may be cylindrical or elliptical, with apertures for introducing the fuel and the subjects to be operated upon, and for conveying away the smoke and vapours.

When the combustion is supported by the current of air naturally excited by the burning of the fuel, it is called a wind-furnace: when it is accelerated by increasing the velocity of the current by bellows, it forms a blast-furnace; and when the body of the furnace is covered with a dome, which terminates in the chimney, it constitutes a reverberatory furnace.

Furnaces are either fixed and built of fire-brick, or portable and fabricated of plate-iron. When of iron, they must be lined with some badly conducting and refractory substance, both to prevent the dissipation of heat and to defend the iron against the action of the fire. A mixture of scales of iron and powdered tiles, worked up with blood, hair, and clay, is much recommended; and Professor Hagen says that it is less apt to split and crack when exposed at once to a violent heat than when dried gradually, according to the common directions. Dr. Black employed two different coatings. Next to the iron he applied a composition of three parts, by weight, of charcoal and one of fine clay, first mixed in the state of fine powder and then worked up with as much water as permitted the mass to be formed into balls, which were applied to the sides of the furnace and beat very firm and compact with the face of a broad hammer to the thickness of about one inch and a half in general, but so as to give an elliptical form to the cavity. Over this, another lute, composed of six or seven parts of sand and one of clay, was applied in the same manner, to the thickness of about half an inch. These lutes must be allowed to become perfectly dry before the furnace is heated, which should at first be done gradually. They may also be lined with fire-bricks of a proper form, accurately fitted and well-cemented together before the top-plate is screwed on.

The general fault of furnaces is, that they admit so much air as to prevent us from regulating the temperature, which either becomes too violent and unmanageable, or, when more cold air is admitted than what is necessary for supporting the combustion, the heat is carried off, and the temperature cannot be raised sufficiently. The superior merit of Dr. Black's furnace consists in the facility with which the admission of air is regulated; and every attempt hitherto made to improve it by increasing the number of its apertures has in reality injured it. See FURNACE and STOVE.

The *stove-holes*, as they are usually termed, are the most useful of all furnaces, and as such are to be found in every well-arranged chemist's laboratory. They are generally constructed in pairs, it being frequently necessary to mix together two liquids at different temperatures, each of which, of course, requires a separate fire to prepare it.

As distillation by the retort is a frequent operation in chemistry, one of these stove-holes is usually fitted for that purpose by having a cast-iron pot about six inches over and as many deep, set sloping in the open space left in the outer wall, and supported in this position by an iron stand adapted for the purpose, and set on the grate. The space between the mouth of the pot and the walls of the furnace is then filled up with pieces of brick and clay. The fitting in of this cast-iron pot, which is intended to contain the glass retort and sand, does not prevent the furnace from being used in many other operations.

When it is intended to use a high degree of heat the top of the retort must be covered with sand: and for this purpose the mouth of the pot must be covered with two plates of sheet-iron, having notches cut in them to let the neck of the retort pass; and smaller notches above these, even with the upper part of the mouth of the pot, to form a circular hole through which sand may be poured to fill up the pot entirely. These iron plates are kept in their proper places by pins inserted in holes drilled in the edge of the pot, or of the iron bands of the furnace. This filling up the sloping iron pot with sand has, however, the inconvenience of preventing the bottom of the retort from being seen.

The other stove-hole will then serve for melting any thing in crucibles or pipkins, and may have as well as the other its cavity contracted by loose bricks upon it. The short wall on the outer side is convenient when only a small fire is required; or when it is intended to distil in a coated glass or earthen retort placed on a piece of brick in the middle of the fire; and, if an iron plate is placed over either stove-hole to form a sand heat, a small hole may, by taking out one of the loose bricks, be left for a vent, if there be no other.

It may easily be conceived that boilers, shallow pans of copper, or even a small copper or tin plate still, may be placed over either of the holes, and, in short, that every operation may be performed with them, except such as require an excessive heat.

As charcoal or coke is usually burned in these stove-holes, they have in general no vents or flues; but, if it be intended to burn raw pit coal in them, or any other smoking fuel, vents must be made in the back wall about eight inches wide and three high, to carry off the smoke: these vents should be about three inches below the top of the furnace, and open into the flue of a chimney, which need not be of any great height.

In foreign laboratories, some of the stove-holes are made with the fire-room from once and a half to twice as deep as it is wide. These deep stove-holes, also, have a couple of iron bars placed across them from front to back, about midway from the grate to the upper edge, which bars are intended to support an earthen retort, an iron-pot for a sand-bath, or any other vessel. These are the furnaces which are called *reverberatory furnaces* by the French authors, and *distillatory furnaces* by the Germans. As the chemists in those countries universally use charcoal for their fuel, their stove-holes have no vent in the back wall opening into a flue; but, in distillations by the naked fire, after stopping up the side opening with clay, the French cover them with a dome of baked earth

the upper part of which is drawn out into a short chimney a few inches in length; and the Germans are content with covering them with a flat slab of fire-stone or a large tile, leaving small openings at the corners for the sake of the draught.

The furnace for the *sand-pot* and *sand-bath* is a very important and useful furnace; but, in the usual way of building such furnaces, they are not only defective and faulty in all the general points before mentioned, but in others also, respecting the proper proportion of this particular kind. This furnace is intended to serve for the sublimation of salts, and distillations of all kinds performed in retorts, as also evaporations from glass or Wedgewood dishes. It heats at the same time, when advantageously constructed, a sand-pot and sand-bath. In the sand-pot any operation may be performed in one retort, where the degree of heat required is from that of boiling oil to the first degree of glowing heat, or what is called red-hot. In general, the retort is sunk in the sand, and even covered with it; but sometimes only as much sand is put in the pot as will keep the retort steady, and this is called a *capella vacua*.

In the sand-bath may be performed several distillations, where different degrees of heat are required, from that of boiling spirits of wine to that of boiling oil, as the bath may be made large enough to contain five retorts or other vessels of the same magnitude, which, by being placed nearer or more remote from the sand-pot, or fixed higher or lower in the sand, may receive the several degrees of heat each shall require.

The first step towards making this furnace is to procure a proper sand-pot, and two large plates for forming the sand-bath. The size of the sand-pot must be determined by the magnitude of the retorts, or bodies, intended to be used in it. It must be so proportioned as to hold the retort, and to allow about two inches' space for the sand to surround it on every side. The best form of sand-pots is that of a cylinder with a concave bottom, which ought to be made double the thickness of the sides. The common pots are generally made with thin bottoms, which subject them to be very soon worn out, if exposed to a strong heat.

The plates for the bath should also be of cast-iron, and must be proportioned to the size and number of retorts, or other vessels, proposed to be worked. They must be long enough to allow at least two inches space betwixt every retort, and two inches and a half betwixt them and the sides of the bath, with the addition of two inches for its bearing on the sides of the hollow it is to cover: the same proportion must be observed for the breadth. They may be as thin as it can be well cast, but care must be taken not to break them in the moving or fixing, which may otherwise very easily happen.

A flat ring of iron, of about three inches breadth, and of a proper magnitude to receive the edge of the pot into a proper groove or rabbet made in its own inner edge, should also be provided.

Two iron doors, with their proper frames and bars for the ash-hole and fire-place, and also an iron frame or slab and bars for the hole for feeding the fire, with other bars and plates for the hollow parts of the furnace, must likewise be prepared, according to the general directions above given. When the iron work is thus prepared, the particular mode of constructing the furnace may be thus described.

The diameter of the sand-pot intended to be used being first taken, six inches must be added to it, for the cavity round the pot, and also the length of two bricks, to allow for the thickness of the sides of the furnace. These, being put together, give the diameter of the whole furnace. To find the due height, the height of the pot must be first taken; to which must be added eight inches for the distance betwixt the pot and the surface of the fire when at the highest, six inches for the depth of the fire-place, and eight inches for the distance of the bars from the ground of the ash-hole; with the height of a brick for a course that must be carried over the edge of the pot, which being all put together give the height of the whole furnace from the foundation.

A round or square cavity must then be made in the ground, on the place where the furnace is to be erected. This must be large enough to admit the laying the foundation of the furnace in it, and about eight inches deep, that the bars of the fire-place may lie on a level with the ground, the ash-hole being below it.

The reason for making this part of the furnace below the ground is to prevent the other parts from rising too high. With respect to the sand-pot, this is a great inconvenience to the operator when he has occasion to put a charged retort into the pot; for in doing this he greatly loses his command of it, if the pot be placed high. But still greater will the inconvenience be with regard to the sand-bath, which, being of course considerably higher than the sand-pot, requires in this case that the operator should have something to stand upon in order to manage the full retorts set into it;—an expedient always to be avoided.

The ground plan or foundation of the furnace must be laid in this hole, of dimensions suitable to the diameter, as computed by the rules above given, and carried up of solid brick-work of a cylindrical or square form. But a sufficient area must be left for the ash-hole, which must be proportioned by laying the bars fixed in their proper situation, by means of the cross-bearing bars in the ground, in the centre of the cylinder, and drawing two lines, begun at the furthest cross bar, and continued parallel to the two outermost bars, at the distance of a quarter of an inch from them, to the front of the cylinder. The space so described must be left hollow, and the ash-pit door set in the front. This part of the work may be done with common bricks and coal-ash mortar; but they must be laid solid, that the whole mass may not shrink when the mortar shall be subjected to a great heat. The cylinder of brick-work being thus raised about eight inches high, the bars of the fire-place must be laid over the innermost part of the vacuity left for the ash-hole; and the stoking-door, with its frame, must be also placed in front of the bars; but they will not, in this manner of construction, coincide with the interior surface or front wall of the furnace. The brick-work must then be again carried up six inches, in the same manner as before; only it must be made to take proper hold both of the cross-bars of the fire-place and frame of the door. But the courses next the fire must be of Windsor brick, and laid with Windsor loam, or Stourbridge clay. If the heat be intended to be very violent, the joints next the fire should be pointed with the proper fire lute.

When the fabric is raised to this height, an iron

plate of sufficient strength, or two broad bars, should be laid over the void part or opening, leading to the door and ash-hole, that the brick-work may be carried entirely round above. The cylinder must then be continued as before, only the cavity must then be made sloping from the upper part of the area designed for the fire-place, and enlarged gradually, so that in raising the furnace eight inches higher the diameter of the cavity shall be six inches more than the diameter of the sand-pot. These six inches are to allow for the three inches distance betwixt the pot and the sides of the furnace, that will here begin to be parallel. The slab for forming the hole for feeding the fire, should be fixed in the last course of bricks which make this slope. The most convenient situation for it is the front of the furnace, directly over the opening for the door and ash-hole.

From this height a cylinder must be carried up parallel to the sides of the sand-pot, at three inches distance, till within something less than a third of the top of the sand-pot, supposing the bottom to be on a level with the first of this cylinder. The hollow then must slope gradually inward till it be no wider than just to suffer the sand-pot to be let down into it.

In the brick-work of this upper slope must be left a cavity for conveying the smoke and flame under the plate of the sand-bath. It must be in the centre of that part where the fabric of the sand-bath joins the furnace, and should be four inches and a half or five inches in length, and about two inches in height.

The whole of this part of the furnace may be of common brick, but the lining should be of Windsor loam. On the top of the brick-work raised to this state, must be laid the iron ring or rim before-mentioned, designed to hold the sand-pot.

It should be laid in with fire-lute, and well pointed with the same at the joint it makes with the bricks within the hollow of the furnace. A proper plate should also be laid over the cavity left for carrying the smoke and flame under the sand-bath.

When these parts of the furnace are so dried as to hold well together, the pot should be let down into the ring, where it must hang by its own rim or turned edge, and another course of bricks then be raised in a continued line with the sides of the sand-pot; that part of them which touches the pot being laid in fire-lute, and the other parts in coal-ash mortar. In this course a slope must be made on the side opposite to the sand-bath or front, whichever shall appear most convenient, for the neck of the retorts to bend sufficiently downwards when placed in the pot. The whole of the furnace which relates to the sand-pot being so completed, the sand-bath must be thus added.

A ground plan or foundation must first be laid, which needs not, in this case, be sunk below the level of the flooring of the place; it must be proportioned according to the size of the plate intended to be used. The length must be that of the plate, with the addition of the breadth of two bricks; the breadth must be that of the plate, and the length of two bricks. It must be formed by building as it were four walls that mark out this proportion; the area within them is to be well paved with square tiles and left hollow. The walls may be built with common bricks and common mortar; only great care should be taken that the bricks may rest every where on each other, so that there may be no settling when the work shall be dry; and that a large iron door and frame be firmly fixed about the middle of the front wall. In adjusting the site of the area marked out for this foundation, about three inches in length of the side of the furnace round the sand-pot must be taken into the end of the area next it. This projection of the one part of the furnace into the other is necessary, in order to bring the end of the plate close to the flue; that is, to convey the flame and smoke into the cavity under it, without being obliged to lengthen the passage, which otherwise must be the case if the whole square of the brick-work of the sand-bath was built in a distinct area, on the outside of the round building for the sand-pot.

The four walls, as before directed, must be carried up till they rise to the level of the lower part of the flue for conveying the smoke and flame.

One of the iron plates should then be laid over this square body; it must be laid in coal-ash mortar on the under side, and the joints on the upper side pointed with Windsor loam.

On this iron plate another empty area must be formed by laying rows of bricks at such distance that the upper plate may rest on them one inch on each side. They must be laid endways to each other; and, for the sides next the plate, Windsor loam should be used; but for the other part coal-ash mortar. The upper plate must be then laid on them and set with fire-lute.

The openings at the two ends into the cavity under the plate must be likewise closed up by bricks laid breadthways, the same caution being used as before for the inside with respect to the kind of mortar. But the opening of the flue for conveying the smoke and flame under the plate must be preserved, and likewise another opening at the other end for the passage of the smoke into the chimney; over which opening a plate, or broad bars, must be laid to support the brick-work of the side over it.

A course of bricks, laid breadthways, must then be raised close to the edge of the plate entirely round it, the joints where they meet the plate being made good with fire-lute, but the rest with coal-ash mortar. Over this course as many others may be laid, but with coal-ash mortar only, as will raise the sides of the bath to a due height; and this must be regulated by the size of the retorts to be used in it.

The chimney for this furnace should be at least twelve or fourteen feet high, and have a cavity of about six inches square.

If this kind of furnace be completed according to the directions here given, and gradually dried, it will continue in order, if carefully used, for a long time. And when the sand-pot, which will be the first part of it that will fail, shall become unfit for further service, the course of bricks above it being removed, it may be taken out of the ring, and the fire-room and other parts of the cavity being repaired and well pointed, a new one may be put in its place, and the course of bricks above it restored. This may sometimes be repeated a third time before there be occasion to take down any other part of the furnace.

For general purposes, the sand-pot is usually twelve inches over on the inside and about nine inches deep, the sand-plates about three feet by two feet, and the door into the oven twelve inches wide, and nine inches high. (See Pneumatic Chemistry.)

Pharos, an edifice erected as a beacon to warn mariners of their approach to any coast or rock which might prove injurious to their safety. The

celebrated light-house built on the island of Pharos seems to have been the first edifice of this description in ancient times. This magnificent tower consisted of several stories and galleries, with a lantern at top, in which a light being continually burning, might be seen 100 miles off. It was accounted one of the seven wonders of the world. It was built by the architect Sostratus, a native of Cnidos, or, according to some, by Deiphanes, the father of Sostratus, and cost Ptolemy Philadelphus 800 talents. The several stories were adorned with columns, balustrades, and galleries of the finest marble and workmanship; to which some add, that the architect had contrived to fasten some looking glasses so artificially against the highest galleries, that the observer could see in them all the ships that sailed on the sea for a great way. Instead of this noble structure there is now only an irregular castle, without ditches or outworks of any strength, out of which rises a tower, which serves for a light-house, but has nothing of the grandeur or beauty of the old one.

The ruins of an ancient pharos still remain on the Castle-hill at Dover. Its form is octagonal without, but square within; the sides of the internal square, and each side of the external octagon, being about fourteen feet in dimensions: the thickness of the wall in the lower part is about ten feet. The foundations were laid in a bed of clay, notwithstanding it is built on a chalk rock, a circumstance that has also been observed in other Roman buildings. It has an arched doorway, about six feet wide on the east side; on the other three sides of the internal square were Roman arches, and narrow spaces for windows, about thirteen feet and a half high, and near four feet wide: these have been much altered in subsequent ages, to convert them into loop-holes. The old arches at the top of these recesses were turned with Roman tiles, and with pieces of stalactitical concretion cut wedge-shaped, about four times the thickness of the tiles, and placed alternately with them.

The dimensions of the tiles in length are different, but their breadth and thickness are nearly the same: the forms of some of them are very singular, especially in the lower part of the building, and on the eastern front: these are on one side furnished with "winding grooves, and with four protuberant hemispherical knobs, nearly equidistant from each corner; and at one end of each tile, near each corner, is a projecting part, of about an inch and three quarters in length, and an inch and a half wide; whilst at the opposite end, near each angle, a void space is left of the same dimensions, so that by reversing the tiles when laid in the wall, the projecting parts might drop into the void spaces like a sort of dovetail work, and render it impossible for them to give way, and slip from each other, in consequence of any internal pressure. With alternate courses formed of these and other Roman tiles, and then of small blocks of stalactitical incrustations was this edifice constructed from the bottom to the top; each course of tiles consisting of two rows, and each course of stalactites of seven rows of blocks, generally about seven inches deep, and about one foot in length. Five of these alternate courses are still discernible, notwithstanding an external casing which was spread over the whole about two centuries ago.

"The component parts of this pharos," says Mr. King, "by a strange coincidence of circumstances, plainly show its age; for it is, like most other Roman buildings, composed of long, thin, irregular bricks; but in the intermediate courses, as no quarries of stone were immediately at hand, both the facing and a great part of the interior substance of the wall were filled up, not, as might have been expected, with flints and chalk rubbish from the neighbouring country, but with a harder and more lasting substance than chalk, though lighter and fitter for carriage; for it is filled up in a most unusual manner, with masses of hard *stalactitical incrustations*, cut into blocks of various dimensions, that could not well have been met with nearer than the northern coasts on the east side of this island, where they abound in great numbers, and which, therefore, could not well have been obtained by any Roman commander prior to the time of *Agricola*, who surrounded the whole island by a regular navigation for the first time; and who might, therefore, most easily, in his ships, convey from the north to the south, these curious and desirable materials, for the purpose of rearing this structure." (See LIGHT-HOUSE.)

PHEONS, in *heraldry*; the barbed heads of darts and arrows, frequently borne in coat armour.

PHILLIPSITE, a newly discovered mineral. (See NATURAL HISTORY division.)

PHILOSOPHY. This word, which is derived from the Greek, literally signifies the love of wisdom; but in its more extended sense may be defined as that study which investigates the phenomena of nature.

These phenomena relate either to the intellectual or material universe, and hence admit of being classified under two distinct departments of study, material philosophy taking cognizance of those phenomena which are the objects of perception; mental philosophy, of those which are the objects of consciousness.

These two branches of science are known by the peculiar denominations of physics and metaphysics: physics the study of external nature; metaphysics the study which comes *after*, or goes beyond physics. These denominations, it may be remarked, arose from the comparative importance of the two branches in the estimation of the ancients. Modern physics, or experimental philosophy, cannot be said to have existed amongst the ancients: in so far, however, as they were guided by demonstration; that is, in geometrical and mechanical science, they made vast and rapid progress. But, in the explanation of nature's unceasing and complicated changes, the philosophers of antiquity made little progress. When they quitted the strong hold of rigid demonstration, it was not to investigate the operations of nature, it was not to scrutinize her visible phenomena, nor to listen to her voice. Their attention, no doubt, was attracted towards some of her most fantastic appearances, and they were occasionally awakened into hearing by any sudden convulsion of the elements; but it was with the glazed eye of mental abstraction that they gazed, and there was more of wonder than philosophy in their listening.

In modern times, on the contrary, experimental philosophy has become an object of ardent and rational pursuit; and the consequence is, that real scientific investigation is constantly adding to the substantial comforts and rational enjoyments of civilized life.

To enable our readers to judge of the ancient